U.S. Geological Survey’s
National Coal Resource Assessment:
Coal Resources of the Northern and Central Appalachian Basin Coal Regions

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INTRODUCTION

The Appalachian Basin is one of the most important coal-producing regions in the nation and the world. Bituminous coal has been mined in the Basin for the last three centuries with cumulative production estimated at 34.5 billion short tons (bst). Annual production in the Basin was about 420 million short tons in 2000 (Energy Information Agency, 2002) and about 95 percent of that production was in the northern and central coal regions (Figure 1). The coal is primarily used within the eastern U.S. for electric power generation but some of it is suitable for metallurgical uses.

The U.S. Geological Survey (USGS), in cooperation with the State geological surveys of Kentucky (KY), Maryland (MD), Ohio (OH), Pennsylvania (PA), West Virginia (WV), and Virginia (VA), has completed a digital coal resource assessment of five of the top-producing coal beds and coal zones in the northern and central Appalachian Basin coal regions. These include the Pittsburgh and Upper Freeport coal beds, the Fire Clay and Pond Creek coal zones, and the Pocahontas No. 3 coal bed (Figure 2). Original and remaining coal resource estimates for these five coal beds and coal zones show that of the 93 bst of original coal, about 66 bst remain (Table 1).

Figure 1. Extent of the northern, central, and southern coal regions in the Appalachian Basin.
Assessment results and data are being released as a two CD-ROM set: USGS Professional Paper 1625-C (Northern and Central Appalachian Basin Coal Regions Assessment Team, 2001). Disk 1 includes chapters of information on (1) the quality and quantity of coal resources in the five assessed coal beds and zones, (2) the Lower Kittanning coal bed, (3) geology and mining history, (4) coal availability, recoverability, and economic evaluations of coal resources studies that have been conducted by the USGS and state geological surveys, and (5) summary reports of other top-producing central Appalachian coal zones.

Disk 2 contains coal resource assessment export files including coal-bed extent, mined area, structure contour, isopach thickness, overburden thickness, and stratigraphic data points. Metadata are included for all assessment coverages. In addition, users may obtain and query the assessment data at http://geode.usgs.gov. Copies of USGS Professional Paper 1625-C can be obtained by emailing the author at lruppert@usgs.gov.

ASSESSMENT METHODOLOGY

More than 1,000 previously published and unpublished maps were digitized and combined in a Geographic Information System (GIS) to create databases that describe the areal extent and mined areas of each assessed coal bed and coal zone. Comprehensive stratigraphic and geochemical databases were built and used to make coal thickness, elevation, overburden thickness, and geochemical maps or coverages and are included on the CD-ROM set. Coverages were combined to calculate original and remaining coal resources. In addition, areal extent, mined areas, and geochemical coverages were compiled for a sixth coal bed, the Lower Kittanning coal bed in the northern Appalachian coal region.

RESULTS OF THE DIGITAL ASSESSMENTS

Northern Appalachian Coal Region

Upper Pennsylvanian Monogahela Group Pittsburgh coal bed

The Pittsburgh coal bed (Figure 3) extends over 5,000 mi² in OH, PA, WV, is high in calorific value, and is used primarily for steam generation. In over 220 years, the Pittsburgh coal bed has produced more coal than any other U.S. coal bed. Currently, it is the top producer in the Appalachian Basin and the second largest in the nation (Energy Information Agency, 2002). Overall, the Pittsburgh is a medium ash and sulfur coal bed (Table 2). Calculated sulfur dioxide (SO₂) values for the coal (Table 2) do not meet current emission standards, but usage of the Pittsburgh continues because the coal is thick, conducive to long-wall mining, and high in calorific value (Table 1). Original resources of the Pittsburgh coal bed are estimated at 34 bst and about 16 bst remain (Table 1). Extensive blocks of thick (6-8 ft), mineable coal occur in southwestern PA and the northern panhandle of WV. Much of the remaining Pittsburgh resource outside of these blocks is high in ash yield and sulfur content and is not likely to be extensively mined in the near future.

Middle Pennsylvanian Allegheny Group Upper Freeport coal bed

The Upper Freeport coal bed (Figure 4) covers more than 14,000 mi² in OH, PA, WV, and MD. Although production is declining, the Upper Freeport remains the third most productive coal bed in this region and the 14th largest producer in the United States (Energy Information Agency, 2000). Overall, the Upper Freeport coal bed is classified as a medium ash, medium sulfur, high calorific value coal (Table 2), but it fails to meet current emission standards. The original total resource is estimated to be 34 bst, of which less than 31 bst remain (Table 1). Pods of thick coal remain, under deep overburden cover (>1,000-2,000 ft), and are unlikely to be mined. Relatively

Figure 2. Generalized stratigraphic column of the coal beds and coal zones in the Appalachian Basin assessed by the USGS. *The Lower Kittanning coal bed was not assessed for original and remaining resources because the stratigraphic database had not been verified.

Figure 3. Sketch map of the extent of the Pittsburgh coal bed.
shallow resources remain in PA and OH that could be mined and combusted in power plants that blend coal or are equipped with flue-gas desulfurization units.

Central Appalachian Basin Coal Region

Middle Pennsylvanian Pottsville Group Fire Clay coal zone

Unlike the Pittsburgh and Upper Freeport coal beds, the Fire Clay is a zone comprising multiple benches of coal and associated rock that are of variable thickness and extent (called Hazard No. 4 in KY and Phillips in VA). Coal benches that are most likely to be mined were used to estimate resources. The Fire Clay coal zone (Figure 5) is distributed throughout approximately 5,500 mi2 in KY, WV, and VA. The coal, mined predominantly from underground mines and used for steam generation, is a high calorific value and a medium ash, low sulfur coal that is blended to meet 2000 emission standards (Table 2). Resource estimates show that 5.1 bst remain of the original 6.3 bst (Table 1). The Fire Clay is expected to continue to be a major producer in the central Appalachian Basin coal region for the next decade.

Lower Pennsylvanian Pottsville Group Pocahontas No. 3 coal bed

The Pocahontas No. 3 coal bed (Figure 7) is present in southern WV and southwestern VA and has produced more high-quality coal than any other coal bed in VA. It continues to be mined and is, in some areas, being exploited for coal-bed methane. The coal bed is low in ash and sulfur, very high in calorific value, and meets current emission compliance standards (Table 2). Resource estimates indicate that the original resource is 7.2 bst of Pocahontas No. 3 coal, and 5.1 bst remain (Table 1). Relatively thick unmined coal remains at depths of 500-1,000 ft and at depths of >1,000-2,000 ft.

Table 2. Arithmetic means of ash yield, sulfur content, calculated sulfur dioxide, and calorific value for the five assessed coal beds and coal zones. For each assessed coal bed and coal zone, 12 additional chemical parameters (antimony, beryllium, cadmium, chlorine, chromium, cobalt, lead, manganese, nickel, selenium, arsenic, and mercury) were mapped and are included on the CD-ROM set. Abbreviations: wt %, arb = weight percent, as received basis; SO2 = sulfur dioxide; Btu/lb = British thermal units per pound.
CONCLUSIONS

The five assessed units produce over 12 percent of the nation’s coal (Energy Information Agency, 2000). Total original resources are estimated at about 93 bst, of which about 66 bst remain. Much of the remaining coal in these coal beds/zones is thinner and deeper than the coal that has been mined, but economic resources are still available and mining in each coal bed/zone is anticipated to continue throughout this decade.

The nation is, and will remain dependent on, coal-fired electric power plants for the majority of our electricity for at least the next few decades. Sufficient coal resources remain in the Appalachians to meet regional electrical generation needs. However, coal quality, not coal quantity, is expected to be the primary control for coal production in the Basin. Environmental constraints will continue to drive production from the plentiful, but higher ash and sulfur, northern Appalachian Basin coal to lower ash and sulfur, central Appalachian Basin coal in the next decade.

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New IEA Research Publication Available from the Center for Applied Energy Research

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David Scott

The liberalization of electric power generation is producing a more competitive environment which, sooner or later, may undermine research and development in the industry and be detrimental to security of electricity supply and to price stability through a loss of fuel diversity. If the effect of liberalization is to transfer wealth from electricity generators to their customers then the former will be less able to support social objectives such as maintaining security of supply and funding research and development. If it is felt that these benefits should be maintained then increased contributions from governments may be needed. This report delves into these issues.

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What is it about energy that captures the attention of politicians, business, the media, and the public? The answer: the fact that none of us can live without it, and our economy and society rely upon affordable and abundant supplies of energy. Mere rumors of an energy shortage can cause upheavals in our society. We assume that gasoline will be at the pumps when we want it, that natural gas will be in the pipes when our furnaces comes on, and that electricity will be in our circuits when we want light, power, and heat. At the same time, our society is demanding better practices and technology in the production of fossil fuels and the generation of electricity to ensure a safe and clean environment.

To keep affordable, abundant, and environmentally acceptable energy available, the United States has a complex system that involves all sectors of society and changes almost daily. Energy in the United States and the world is constantly being discussed and debated in the media, and the big picture can be overwhelming. Instead, if we take a look at a smaller piece of the picture—Kentucky—perhaps we can gain some insight into the complexities of our energy situation.

Kentucky’s Energy Profile and the Need for Research

Let’s look at Kentucky’s “energy profile,” derived from statistics compiled by the Energy Information Administration.

<table>
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<th>MEASURE</th>
<th>UNITS</th>
<th>STATE RANKING</th>
</tr>
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<tbody>
<tr>
<td>Population</td>
<td>4.04 million people (2000)</td>
<td>25th</td>
</tr>
<tr>
<td>Total energy consumption</td>
<td>1.9 quadrillion Btu (1999)</td>
<td>18th</td>
</tr>
<tr>
<td>Per capita energy consumption</td>
<td>462 million Btu (1999)</td>
<td>8th</td>
</tr>
<tr>
<td>Total petroleum consumption</td>
<td>15.5 million gallons per day</td>
<td>17th</td>
</tr>
<tr>
<td>Average retail price of electricity</td>
<td>4.17 cents/kilowatt hour (1999)</td>
<td>49th</td>
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</tbody>
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Kentucky ranks high in total energy consumption (18th), very high in per capita energy consumption (8th), and high in total petroleum consumption (17th). But Kentucky ranks only 25th in population, so our consumption of energy is well above what would be predicted based solely on population. On the other hand, Kentucky ranks 49th in average retail price of electricity, which is directly related to our higher use of coal compared to many other states. Explaining Kentucky’s ranking in all of these energy areas would require analysis beyond the scope of this editorial. Kentucky’s electrical energy production includes a mix of energy sources. Currently, Kentucky’s electrical power mix is 87 percent coal, 7 percent natural gas, 5 percent hydroelectric, and 1 percent oil. In comparison, California ranks 9th in average retail price of electricity and 49th in per capita energy consumption, just the opposite of Kentucky. California’s primary electrical energy sources are nuclear and natural gas, which have a higher average cost than coal. The recent turmoil in California’s electrical power system shows how serious problems related to energy supply can get.

PRODUCTION AND CONSUMPTION IN KENTUCKY

How does Kentucky’s production of energy resources stack up against its consumption of them? The table below shows that Kentucky produces about 1.8 times as much energy as it consumes. In order to make the comparisons, the units of coal, oil, and natural gas are shown in the table converted to their common energy content in British Thermal Units (Btu). The amount of energy consumed from coal in Kentucky is about equal to the energy consumed from oil and natural gas combined (oil includes all heating and transportation fuels such as heating oil, gasoline, and diesel, and other petroleum products). Kentucky consumes about 40 million tons of its own coal production and ships about 100 million tons to other states. In contrast, we produce only about 2 percent of the oil and 36 percent of the natural gas that we consume. Kentucky is not self sufficient in petroleum products or natural gas and receives these products from other states just as Kentucky coal is shipped to 24 other states. Some of the coal consumed in Kentucky is converted to electrical power that is distributed to other states.

<table>
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<tr>
<th>PRODUCTION</th>
<th>CONSUMPTION</th>
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<tbody>
<tr>
<td>Amount</td>
<td>Equivalent Btu (trillion)</td>
</tr>
<tr>
<td>Coal</td>
<td>139 million tons 3.432</td>
</tr>
<tr>
<td>Oil</td>
<td>2.9 million barrels 17</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>77 billion cubic feet 77</td>
</tr>
<tr>
<td>TOTAL</td>
<td>3.526</td>
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Kentucky has abundant energy resources in the form of fossil fuels, and these resources have played significant roles in the development of Kentucky and the Nation. As the State Geologist and Director of the Kentucky Geological Survey, I spend a large part of my time providing information about
Kentucky’s Energy Profile (cont.)

Kentucky’s fossil energy and also managing research programs aimed at estimating and characterizing our fossil fuel resources, and discovering new resources. The first published report by the Kentucky Geological Survey in 1854 gave descriptions and chemical analyses of coal resources. The Survey began investigating natural gas and oil in the late 1800’s, and Kentucky’s first big oil field was discovered in 1903. Literally hundreds of other reports and maps have been published by the Survey in its 148-year history that describe the oil, natural gas, and coal resources of the state, for the purpose of helping in their production for the benefit of our citizens. Today much of the Survey’s information on fossil energy resources is provided by the World Wide Web at www.uky.edu/KGS. Kentucky’s energy resources will be important subjects for research in the future, as they have been in the past.

THE FUTURE

The research on energy resources that began in Kentucky more than 100 years ago helped to achieve the fuels, processes, and applications we have today. But, how will our energy profile change in the future? What will our energy production and consumption be, and what will their costs and benefits be? I can’t answer such complex questions, but these are areas where continued research and development are needed to stimulate progress. Kentucky has extensive resources of fossil fuels that should be used for the benefit of society well into the future. These resources must be used in an environmentally and economically sound way. The Center for Applied Energy Research and the Kentucky Geological Survey are two agencies of the University of Kentucky charged with the responsibility of conducting energy-related research that will help solve problems in the future. We don’t have all the answers yet—we don’t even have all the questions yet! But we’re fortunate to live in a state with energy resources, as well as research facilities and scientists dedicated to helping Kentucky and the nation meet our energy and environmental needs.

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